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96-45

September 23, 1997

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Mr. William F. Caton
Office of the Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, D.C. 20544

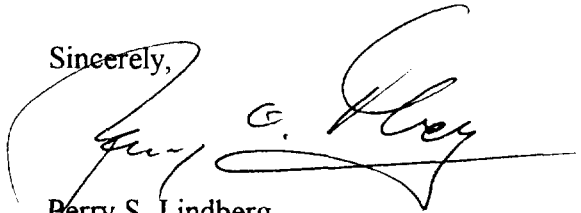
Re: xDSL Presentation to the Commission

Dear Mr. Caton:

On September 19, 1997, the Commission was introduced to xDSL Technologies. The presentation was held by myself and the content covered is attached.

An original and one copy of this letter and presentation overheads are being submitted to the Secretary of the FCC. One copy is being submitted to Vaikunth N. Gupta of the Universal Service Branch for further distribution to the attendees below.

Sincerely,




Perry S. Lindberg
Vice President, Strategic Programs

Attachment

cc: Vaikunth Gupta
Bryan Clopton
Bob Loube
C. Anthony Bush
Bill Sharkey
Chuck Keller
Natalie Wales
Emily Hoffner

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PAIRGAIN

THE COPPEROPTICS COMPANY

COPPEROPTICS[®]

**Digital transmission at fiber optic quality over
unconditioned copper wire**

Agenda

- ◆ xDSL Market
- ◆ xDSL Tutorial
- ◆ xDSL vs. ISDN
- ◆ Key Applications/Considerations for xDSL
- ◆ xDSL Financial Models
- ◆ xDSL Market Development
- ◆ Service Pricing
- ◆ Summary

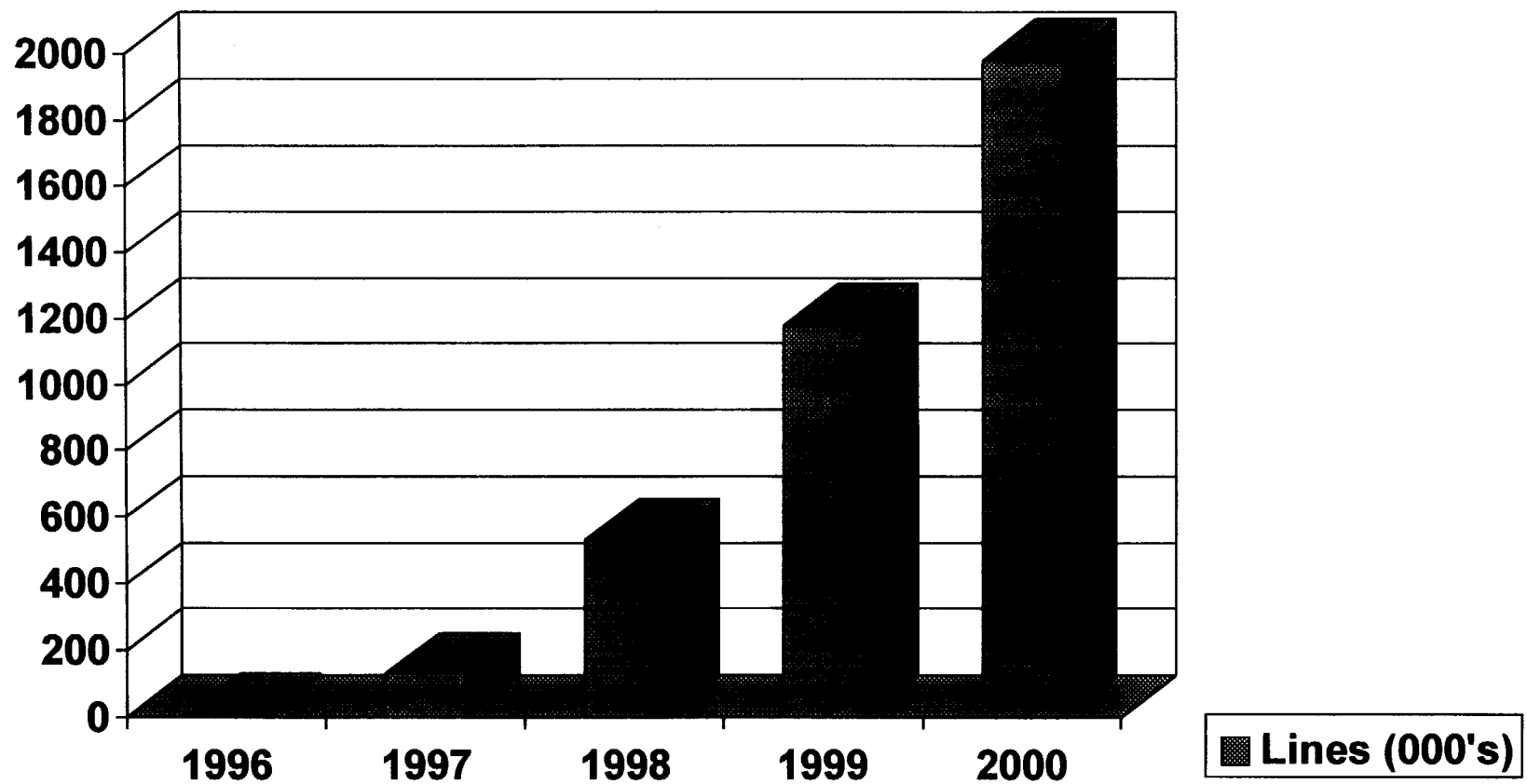
Market Hype



xDSL Megabit Access

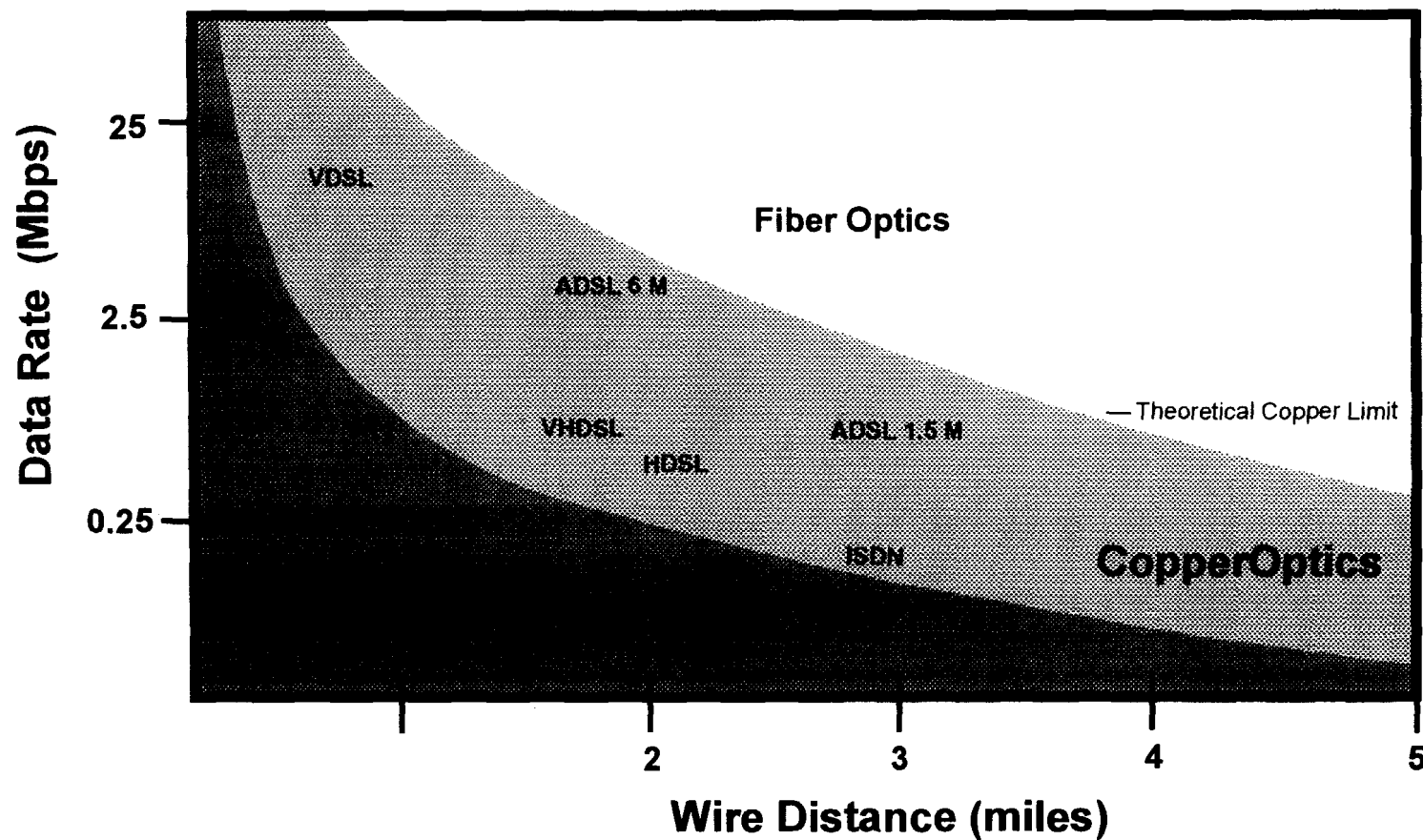
- ◆ High-speed digital transmission - data/video/voice
 - Symmetric and Asymmetric
 - Rates from 384 kbps up to 6 Mbps
- ◆ Uses existing unconditioned twisted-pair copper
 - High reliability and performance (10^{-10} BER)
 - Crosstalk immunity
- ◆ Extended distances beyond CSA - up to 5 miles
- ◆ Low cost

xDSL Market Forecast - Lines



Source: Yankee Group

Market Opportunity



Deployment Infrastructure Exists

- ◆ 690 million phone lines worldwide
 - 172 million in United States
 - 203 million in Europe
 - 138 million in Pacific Rim

xDSL vs. ISDN

| | xDSL | ISDN |
|--|--------------------------|--------------------------|
| Installed Base | 400,000 lines | 1,000,000 lines |
| Bandwidth | 128 kbps to 7 Mbps | 128 kbps |
| Infrastructure | Local Area Network (LAN) | Addition to voice switch |
| Packet vs. Circuit Switched | Packet switched | Circuit switched |
| POTS | Lifeline | No |
| Reach | 12 to 22 kft (24 AWG) | 18 kft (24 AWG) |

xDSL Technologies

- ◆ **High-bit-rate Digital Subscriber Line (HDSL)**
 - Two-pair technology using 2B1Q line code (signaling)
- ◆ **Single-Pair HDSL (S-HDSL)**
 - Single-pair technology using 2B1Q line code (signaling)
- ◆ **Asymmetric Digital Subscriber Line (ADSL)**
 - Carrierless Amplitude Modulation/Phase Modulation (CAP)
 - This is the line code used by the GlobeSpan chipset
 - Discrete Multi-Tone (DMT)
 - This is the official line code in the ANSI standard
- ◆ **Symmetric Digital Subscriber Line (SDSL)**
 - This is GlobeSpan's CAP technology configured to operate in symmetric mode
- ◆ **Rate Adaptive Digital Subscriber Line (RADSL)**
 - This adaptation of the ADSL technologies automatically provides the best transmission rate for the length and condition of the line

Rates, Reaches & Spectral Compatibility

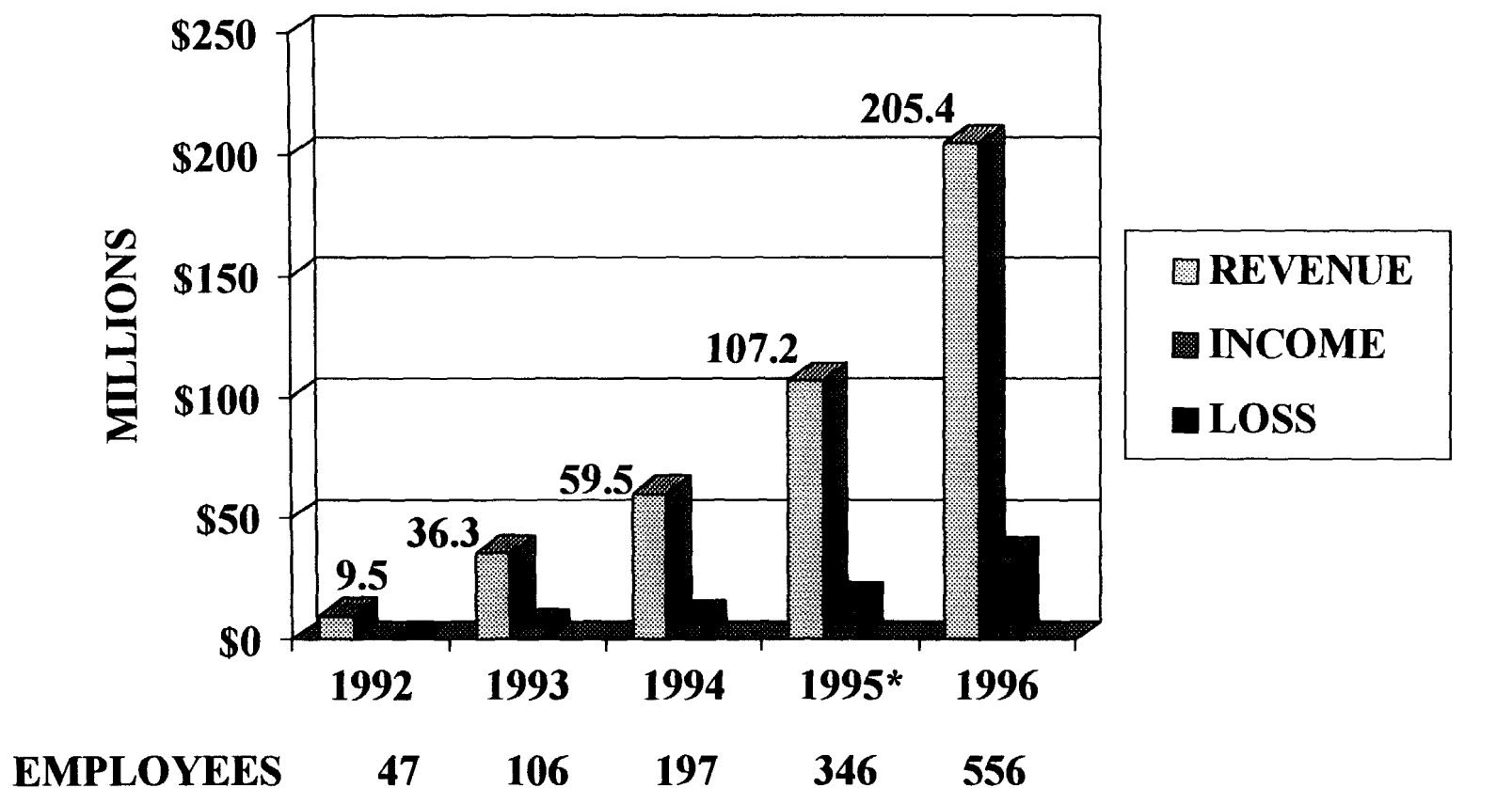
| xDSL Type | Nominal Reach 26AWG | Repeater - able? | Maximum Downstream Rate (kbps) | Maximum Upstream Rate (kbps) | Spectral Compatibility | | | |
|-------------|------------------------|---------------------|-----------------------------------|---------------------------------|------------------------|-------------------|--------|------|
| | | | | | T1* | Adj Binder T1* | HDSL | ISDN |
| ISDN | RRD - 15.6 kft | ✓ | 144 | 144 | ✓ | ✓ | ✓ | ✓ |
| S-HDSL 768 | CSA - 9 kft | ✓ | 768 | 768 | ✓ | ✓ | ✓ | ✓ |
| DMT ADSL | 13.5 kft | | 1544 | 176 | 11 kft | ✓ | 12 kft | ✓ |
| DMT ADSL | CSA | | 6144 | 640 | 4.5 kft | 7.2 kft | ✓ | ✓ |
| CAP 1.5M/64 | 13.5 kft | | 1544 | 64 | 9.5 kft | 12.7 kft | 12 kft | ✓ |
| CAP 6M/64 | CSA | | 6312 | 64 | 4.5 kft | 7.2 kft | ✓ | ✓ |

* Reaches reflect 10 T1 or Adj. T1 disturbers, HDSL reaches are 49 disturbers

PairGain Today

- ◆ 400,000+ units installed
- ◆ 75%+ domestic market share
- ◆ Approved by all RBOCs
 - Sole/primary source to five RBOCs
- ◆ STENTOR standard
- ◆ High volume, low-cost producer
- ◆ Feature-rich technology leader
- ◆ 80%+ annual growth rate
- ◆ 90% of customer deliveries - 48 hours ARO

Company Growth




* Excluding unauthorized trading losses

PairGain's xDSL Solutions

- ◆ **T1/E1 HDSL - HiGain**
 - Over 200,000 systems installed, 70% market share
 - Approved by all RBOCs and most major independents
- ◆ **Small Subscriber Carrier - PG-2, PG-Flex, PG-Plus**
 - Copper pair shortage
- ◆ **Campus Area Networks - Campus**
 - Universities, military bases, corporate campuses
- ◆ **Megabit Access - Megabit Modem/EtherPhone**
 - Internet Access - Consumer and business
 - Telecommuting
 - Remote LAN access (TLS)

xDSL Applications

Internet Surfing 



Remote LAN Access

Desktop Video Conferencing



Collaborative Computing

Email



Distance Learning

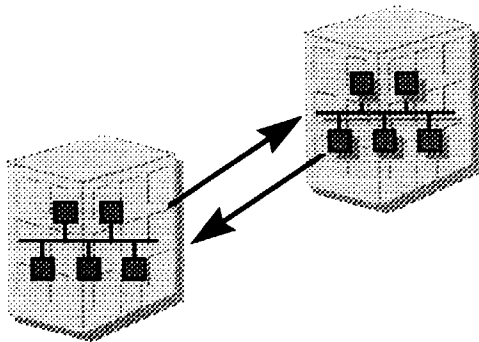
Telemedicine 

Application Response Times

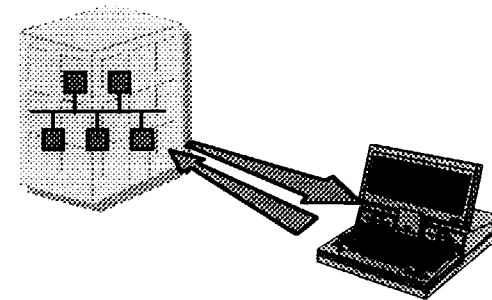
| APPLICATION | FILE SIZE | Modem 28.8 kbps | ISDN 128 kbps | xDSL 384 kbps | xDSL 768 kbps | xDSL 1544 kbps | xDSL 6144 kbps |
|-----------------------------------|-----------|-----------------------|---------------------|---------------------|---------------------|----------------------|----------------------|
| All users Email | | 8.3 Sec. | | | | | |
| Consumer Digitized Photo | | 34.7 Sec. | 7.6 Sec. | | | | |
| Business User Word files | | 69.4 Sec. | 15.6 Sec. | 5.2 Sec. | | | |
| Telecommuter Videoconferencing | | No | No | | | | |
| Telemedicine X-ray | | 23.1 Min. | 5.2 Min. | 1.7 Min. | 52.1 Sec. | | |
| Rem LAN Access Bulk File | | 1.6 Hours | 20.8 Min. | 8.9 Min. | 3.5 Min. | 1.7 Min. | |

Desired and acceptable response time is less than 3.0 seconds

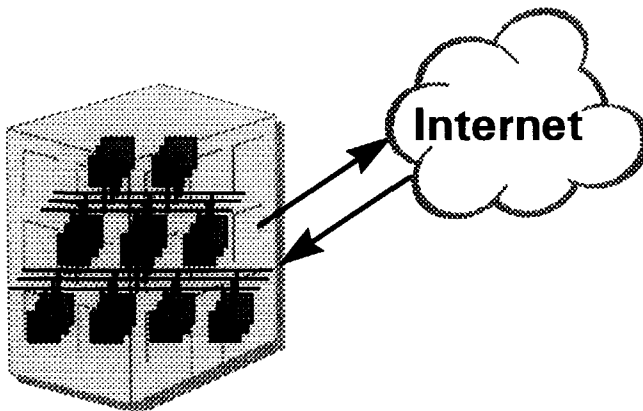
xDSL Services



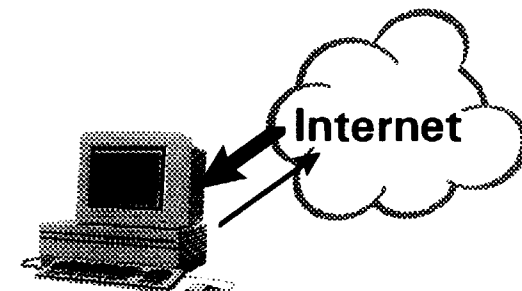
Transparent LAN Service



Telecommuter / SOHO

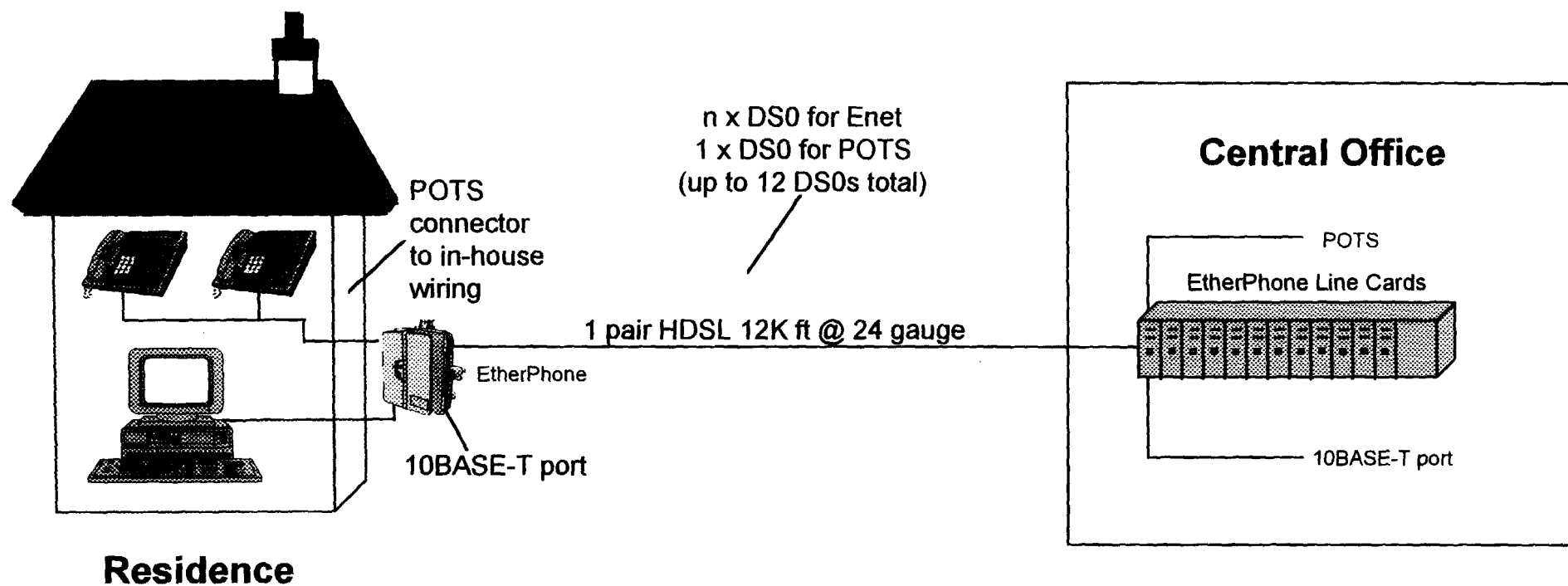


Business Internet



Consumer Internet

EtherPhone™ RT



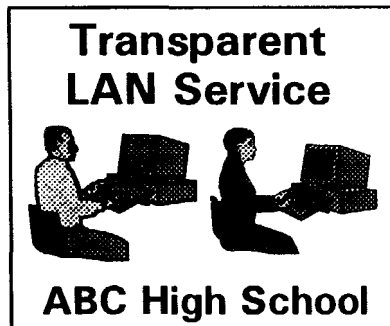
Worldwide Internet Users Growing

- ◆ Just 36 million Internet users today
- ◆ More than 100 million in 1998
- ◆ Close to 250 million in 2000

Service Pricing Expectations

- ◆ Initial pricing high (\$100+) and aimed at businesses
- ◆ Consumer-based services in \$30-\$50 range emerge in 1997
- ◆ Unlimited access but perhaps at fixed rates

ABC School District - Transparent LAN Service



Use/purpose

Connect together Ethernet networks in different buildings to share traffic

Network Description

Two or more LANs bridged to a common LAN backbone via dedicated xDSL circuits

Symmetrical/Asymmetrical

Symmetrical

Deployment Timeframe

NOW

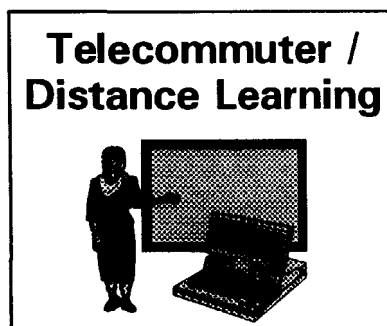
Typical Price Range

\$200 to \$1,000/month per line

Equipment Considerations/Other

Transparent LAN service users usually require dedicated bandwidth

ABC School District - Telecommuter/SOHO



Use/purpose

Allow distance learning, on-line homework, library access, tutoring, assignment review

Network Description

Connect a remote PC to the school server/central LAN via a dedicated xDSL circuit

Symmetrical/Asymmetrical

Usually symmetrical

Deployment Timeframe

NOW for "high-end" users

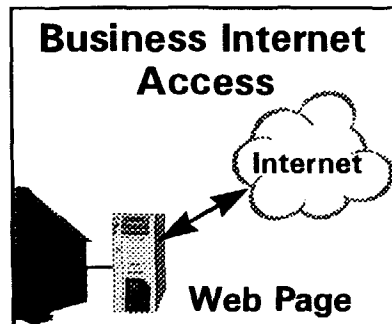
Typical Price Range

\$100 to \$300/month per line

Equipment Considerations/Other

Moderate "oversubscription" OK

ABC School District - Business Internet



Use/purpose

On-line research projects for students, teachers. High-speed access to Web page

Network Description

LAN-attached PCs and Web page server share a high-speed symmetrical line to ISP

Symmetrical/Asymmetrical

Symmetrical

Deployment Timeframe

NOW

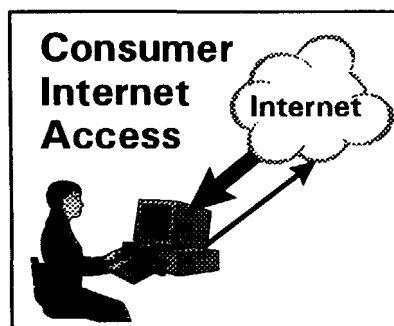
Typical Price Range

\$300 to \$1,000/month per line

Equipment Considerations/Other

School district may require dedicated bandwidth to Internet backbone

Consumer - High-Speed Internet Access



| | |
|---------------------------------------|---|
| Use/purpose | <i>Consumers "surf the net" from home with high-performance access</i> |
| Network Description | <i>LAN-attached PCs in user's home share a high-speed asymmetrical line to ISP</i> |
| Symmetrical/Asymmetrical | <i>Usually asymmetrical</i> |
| Deployment Timeframe | <i>Two to three years</i> |
| Typical Price Range | <i>\$20 to \$50/month per line</i> |
| Equipment Considerations/Other | <i>High oversubscription ratios and high density, low cost concentration required</i> |